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DRAFT
Discharge Assessment Report
Weather Deck Runoff

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DRAFT

DISCHARGE ASSESSMENT REPORT

DECK RUNOFF

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1.0 Introduction: Deck Runoff Discharge Assessment Report

The National Defense Authorization Act of 1996 amended Section 312 of the Federal Water Pollution Control Act (also known as the Clean Water Act (CWA)) to require that the Secretary of Defense and the Administrator of the Environmental Protection Agency (EPA) develop uniform national discharge standards (UNDS) for vessels of the Armed Forces for "…discharges, other than sewage, incidental to normal operation of a vessel of the Armed Forces,…" [Section 312(n)(1)]. UNDS is being developed in three phases. The first phase determined which discharges were required to be controlled by marine pollution control devices (MPCDs), which may be equipment, alternative materials, or management practices. The second phase (which this report supports), characterizes each discharge, along with evaluating the environmental effects and feasibility of MPCDs for each discharge. The final phase will determine the design, construction, installation, and use of the MPCDs.

Discharge Assessment Reports (DAR) are prepared for each vessel discharge requiring control as listed in the Code of Federal Regulations (CFR). A DAR is a summary of the technical documents prepared during the second phase of UNDS. These documents include: vessel grouping documents, characterization reports, MPCD screening documents, environmental effects analysis reports, and feasibility impact analysis reports. The information in these documents is obtained from discharge sampling and subsequent analyses, manufacturer's data and recommendations, observations, process knowledge, and research.

The purpose of the DAR is to present key features of a discharge to allow decision makers to balance the seven statutory considerations to produce a performance standard for each vessel group that generates the discharge. The seven considerations are:

- The nature of the discharge;
- The environmental effects of the discharge;
- The practicability of using the MPCD;
- The effect that installing or using the MPCD would have on the operation or the operational capability of the vessel;
- Applicable U.S. law;
- Applicable international standards; and
- The economic costs of installing and using the MPCD.

The DAR is organized into six sections: discharge description; applicable laws and standards; vessels generating the discharge; MPCD options and screen results; discharge overview; and references. The discharge overview is divided into four subsections: the nature of discharge for each vessel group; a summary of the feasibility and environmental effect impacts; cost-benefit analysis (cost per toxic pound equivalent (TPE) removed); and summary of vessel group analysis.

1.1 General Discharge Description

This section provides a description of deck runoff.

1.1.1 Deck Runoff Definition

Deck runoff is defined in 40 CFR 1700.4 as the precipitation, washdowns, and seawater falling on the weather deck and exposed portions of a vessel and discharged overboard through deck openings. A vessel intermittently produces deck runoff when water falls on or is applied to exposed surfaces, such as weather and flight decks, superstructure, bulkheads, and the hull above the waterline of a ship (e.g., freeboard and bulwark). Discharge constituents vary depending on the vessel's topside processes, and may include oil, grease, petroleum hydrocarbons, surfactants, cleaners, glycols, solvents, and particulates (e.g., soot, dirt, or metallic particles). One of the primary mechanisms for these constituents getting into deck runoff is that they become trapped in the rough deck surface (such as crevices, corners, and other irregularities of a deck surface) and are washed overboard during periods of rough seas or precipitation. All vessels generate deck runoff.[1]

1.1.2 Deck Runoff Categories and Processes

To facilitate Phase II analyses, processes that contribute constituents to deck runoff were separated into six categories. The processes were grouped together according to the types of constituents in each process contributing to deck runoff. The categories and processes are shown in Table 1-1; section 5 includes a detailed discussion of these categories and processes.

Table 1-1: Deck Runoff Categories and Processes

Category	Processes (Including Operation & Maintenance)
Aircraft Launch and Recovery Equipment	• Arresting Gear • Catapult Operations • Jet Blast Deflectors
Buoy Maintenance	• Maintenance and Preservation of Buoys
Cleaning Activities/General Housekeeping	• Aircraft Washdowns • Electronic Intelligence/Navigation Systems Maintenance • Equipment and Vehicle Washdowns • Exterior Topside Surface Washdowns • Firemain Systems (For use in exterior washdowns)
Deck Machinery and Weapons Lubrication	• Aircraft Elevators • Buoy Handling Systems • Fire Assist Vehicles • Mine Handling Systems • Recovery, Assist, Securing, and Traversing Systems • Ship's Boats/Launching Systems • Stores Handling Systems • Towing and Mooring Systems • Weapons Systems
Exterior Topside Surface Preservation	• Restoration of Painted Surfaces • Flight Deck Safety Nets
Vessel, Aircraft, and Vehicle Refueling and Lubrication	• Aircraft Refueling • Fixed Wing Aircraft Maintenance and Operations • Fuel Transfer Systems • Ground Support Equipment • Rotary Wing Aircraft Maintenance and Operations

[1] *To facilitate the UNDS Phase II analysis, the Discharge Assessment Team (DAT) determined that water that falls on or is applied to exposed surfaces and accumulates in the lowest part of the vessel (i.e., bilge) is classified as surface vessel bilgewater. Associated analyses are presented in the Surface Vessel Bilgewater Reports.*

2.0 Applicable Laws and Standards

2.1 Introduction

This section describes applicable U.S. and International law that is relevant to the deck runoff discharge.

Applicable International Law, Standards, and Conventions

2.2 No international standards for deck runoff were identified.

2.3 Applicable U.S. Law

There are no U.S. laws that specifically apply to "deck runoff." However, implementation of the Clean Water Act (CWA) and Executive Order 13148, "Greening the Government through Leadership in Environmental Management" addresses the release of some constituents that contribute to the environmental impact of the deck runoff discharge.

- CWA, § 311(b)(3) prohibits discharges of oil or hazardous substances in harmful quantities into the navigable waters of the United States and the contiguous zone. EPA has by regulation of 40 CFR 112 and 40 CFR 300 defined the amounts of oil and hazardous substances, respectively, that are considered harmful. Current practices aboard armed forces vessels, if codified, would help ensure that constituents in weather deck runoff do not exceed harmful amounts.
- State numeric and narrative water quality standards, which may vary by designated usages of individual water bodies, are set under the authority of the CWA. States use such standards to regulate both point and non-point sources. Environmental effects analyses, performed to support the development of discharge standards, compare constituent concentration levels and other characteristics of the discharges to appropriate State water quality standards.
- Executive Order 13148 requires Federal leadership in environmental management (Office of the President, 2000). Agencies are mandated to promulgate policies that incorporate pollution prevention (P2) planning. "Each agency shall advance the national policy that, whenever feasible and cost effective, pollution should be prevented or reduced at the source," (Office of the President, 2000). Complying with this instruction reduces the amount of constituents in deck runoff.

3.0 Vessels Generating Deck Runoff

3.1 Introduction

The criteria for vessel grouping are found in the *Development of Vessel Groups and Selection of Representative Vessel Classes for Feasibility and Environmental Effects Analyses* guidance. A vessel group is defined as a set of vessel classes with enough similar operational and discharge characteristics to allow application of feasibility analyses and environmental effects analyses conclusions to all vessels within the group.

All vessels generate deck runoff. Multiple topside processes contribute constituents to deck runoff. Some of these processes occur across most vessel classes (e.g., preservation of exterior topside surfaces), while other processes are limited to a few vessel classes (e.g., launching of fixed wing aircraft by aircraft carriers). The constituents in deck runoff are directly related to the topside processes on that vessel; because there are many different combinations of topside equipment, forming vessel groups is ineffective. Therefore, vessel groups for deck runoff were not created as described in the *Development of Vessel Groups and Selection of Representative Vessels for Feasibility and Environmental Effects Analyses* guidance (EPA and DOD, 2000a). Alternatively, the Navy and EPA organized the topside processes that contribute constituents to deck runoff into six main categories, as explained in Section 1.0 and Table 1-1, and analyzed each category.

4.0 Potential Marine Pollution Control Devices (MPCDs) Option Description and Screen Results

4.1 Introduction

Potential marine pollution control devices (MPCD) options to control deck runoff were identified through a variety of sources including: Phase I analyses, current practices, process knowledge, literature and internet research, and responses to sources sought announcements (Navy, 2000; Navy, 2001b; Navy, 2001c; Navy, 2001d; Navy 2001e; Navy, 2001f; Navy, 2001g). The following MPCD options were identified: effluent capture and containment system (ECCS), *ex situ* biological treatment, filter media, flocculation through electrocoagulation, flocculation by separating agents, supercritical water oxidation, and topside management plan (TMP).

Each MPCD option was screened to determine which MPCDs have been sufficiently proven for controlling deck runoff. The next sections briefly describe each MPCD option and the results of the screen. More details on these MPCD options and the screen analysis can be found in the MPCD screen reports (Navy, 2000; Navy, 2001b; Navy, 2001c; Navy, 2001d; Navy 2001e; Navy, 2001f; Navy, 2001g).

From the seven MPCD options identified, only the TMP passed the screen criteria. With the exception of the TMP, all the MPCD options identified would require the collection of deck runoff. This would not be feasible. Table 4-1 summarizes the results of the MPCD options identified and the resulting screening analysis.

Table 4-1: Deck Runoff Screens

Screen	Source of MPCD	Pass/Fail and Reason
Topside Management Plan	Identified in Phase I	Pass.
Effluent Capture and Containment	Response to sources sought announcement	Fail. Not used on waterborne vessels.
***Ex Situ* Biological Treatment**	Response to sources sought announcement	Fail. Not used on waterborne vessels to treat deck runoff.
Filter Media	NSWCCD* input and response to sources sought announcement	Fail. Not used on waterborne vessels to treat deck runoff.
Flocculation through Electrocoagulation	Response to sources sought announcement	Fail. Not used on waterborne vessels.
Flocculation by Separating Agents	Response to sources sought announcement	Fail. Not used on waterborne vessels.
Supercritical Water Oxidation	Response to sources sought announcement	Fail. Not used on waterborne vessels.

*Naval Surface Warfare Center Carderock Division (NSWCCD) submitted filter media as an MPCD option for six UNDS discharges: Catapult Water Brake Tank and Post Launch Retraction Exhaust, Deck Runoff, Firemain Systems, Gas Turbine Water, Submarine Bilgewater, and Surface Vessel Bilgewater/OWS.

4.2 Topside Management Plan

The TMP is the only MPCD option group that passed the screening process as outlined in the *Marine Pollution Control Device Screen Guidance Document*. Initially, a fleet wide topside management plan (FTMP) would be developed. The FTMP would address deck runoff constituent sources (i.e., process categories), list activities that could be implemented to prevent the discharge of those constituents, and specify documentation procedures. Objectives would be developed for each category to describe the desired potential controls and expected results. The fleet wide plan would be distributed to individual vessel program offices or commands. Subsequently, the program offices or commands would develop a vessel topside management plan (VTMP). A VTMP would be a vessel-specific plan that identifies deck runoff constituents and their sources, identifies the objective for each applicable category that may contribute to deck runoff, suggests practices and/or specifies measures to achieve the objective(s), and specifies documentation requirements. Every vessel would be required to implement a VTMP. Individual vessels or commands would tailor the fleet wide plan to address only those topside categories that contribute to the vessel's deck runoff. The applicable activities listed in the FTMP, or their equivalent would be incorporated into a VTMP so that the vessel would achieve FTMP objectives. The activities in the FTMP would not necessarily be comprehensive and are intended to provide examples of how a vessel may achieve each objective. Vessels would be free to add new, innovative activities. Similar small vessels under the same command could share one VTMP, if appropriate.

When an activity fails to meet the control objective, that failure would trigger a revision of the VTMP to address the failure. Also, the VTMP and the FTMP would be reviewed periodically to address changes in topside processes and new mitigation techniques.

4.3 Effluent Capture and Containment System

The ECCS is a self-contained platform with berms around the perimeter that collect and contain wash water from land-based aircraft washdowns and other land-based cleaning operations. This technology has not been tested or proven in the marine environment (Navy, 2000). Therefore, ECCS fails the MPCD screen criteria.

4.4 *Ex Situ* Biological Treatment

Biological treatment is defined as "a treatment technology that uses bacteria to consume organic waste," (EPA, 1998). *Ex situ* biological treatment has not been used to treat deck runoff on waterborne vessels (Navy, 2001g). Therefore, *ex situ* biological treatment is not considered sufficiently proven and fails the MPCD screen criteria.

4.5 Filter Media

Filter media are substances that selectively remove constituents (e.g., organics and metals) from wastewater. There are no known instances of filter media being used to treat deck runoff (Navy, 2001f). Therefore, filter media fails the MPCD screen criteria.

4.6 Flocculation through Electrocoagulation

This process results in the destabilization and aggregation of smaller particles into larger particles. The resulting larger particles precipitate from solution or become large enough to be filtered out of solution. Flocculation through electrocoagulation is not proven on waterborne vessels (Navy, 2001b). Therefore, flocculation through electrocoagulation fails the MPCD screen criteria.

4.7 Flocculation by Separating Agents

Although achieved through different means, both coagulation and flocculation are processes by which suspended material present in water in a colloidal form are brought together into larger agglomerates. These agglomerates are then removed during wastewater processing by skimming and filtration. Flocculation by separating agents is used on shoreside wastewater treatment plants. However, this technology has not been used to treat deck runoff on waterborne vessels (Navy, 2001c). Therefore, flocculation by separating agents fails the MPCD screen criteria.

4.8 Supercritical Water Oxidation

This potential MPCD uses supercritical water oxidation (SCWO) unit to control aqueous organic materials by converting them to carbon dioxide and water. SCWO technology is available for commercial use, but has not been used on a waterborne vessel or in the marine environment to treat deck runoff (Freeman, 1989; Navy, 2001d). Therefore, supercritical water oxidation fails the MPCD screen criteria.

5.0 Deck Runoff Overview

5.1 Introduction

Section 5.1 provides an overview of the analytical approaches to deck runoff characterization, feasibility, and environmental effects analyses, assuming the use of a TMP. Section 5.2 provides a summary of the costs associated with developing and managing TMP implementation. Sections 5.3 through 5.9 summarize the results of a limited feasibility and environmental impact analysis of example prevention TMP activities. The list of prevention activities is not considered to be exhaustive. The results of these analyses are organized by each deck runoff category (See Table 1-1 for the list of deck runoff categories).

The following information is provided for each deck runoff process category:

- Category summary;
- Nature of discharge summary based on the Characterization Report; and
- Summary of the Feasibility Impact Analysis Report (FIAR) and Environmental Effects Analysis Report (EEAR) for each category and example activities.

5.1.1 Characterization

In Phase I, deck runoff was separated into three categories: aircraft flight decks, oiler weather decks, and weather decks, based generally on the uniqueness of operations performed, exposed materials, and containment of those materials (EPA and DOD, 1999). However, in Phase II, Navy and EPA expanded the categories based on additional data and created six categories of processes that were based on the anticipated pollution prevention practices and contributing constituents (see Table 1-1). To evaluate deck runoff, a team of Armed Forces equipment experts visited vessels representing different Navy and Coast Guard vessel classes to determine how various topside processes contribute to deck runoff (Wenzel *et al*, 2001a). A shipboard assessment was conducted to observe and document topside equipment and processes, cleaning practices, associated materials, and potential contributions to deck runoff (Wenzel *et al*, 2001a). Sailors were also interviewed to identify potential techniques for reducing or eliminating discharge constituents. Finally, the assessment identified specific topside processes that can add constituents to deck runoff.

The Characterization Report (ChAR) describes these six Phase II deck runoff categories and the constituents that may be contributed by each. For a detailed discussion of the categories, processes, and constituents, refer to the ChAR (Navy, 2002a).

5.1.2 Feasibility

The deck runoff Feasibility Impact Analysis Report (FIAR) examines three of the seven statutory considerations for establishing performance standards for marine pollution control devices (MPCDs):

- Practicability of using the MPCD;
- Effect that installation or use of the MPCD would have on the operation or operational capability of the vessel; and
- Economic costs of the installation and use of the MPCD.

The FIAR analyzes example activities that may be implemented by the TMP to achieve the objective for each deck runoff category. This DAR summarizes these analyses by category. For a detailed discussion of the feasibility analyses, refer to the FIAR (Navy, 2002b).

5.1.3 Environmental Effects Analysis

The environmental effects analysis report (EEAR) addresses the six process categories and the example practices that may be included in a TMP to achieve the control objectives. The EEAR presents qualitative comparisons to narrative water quality criteria. Process knowledge was used to assess the presence of non-indigenous species (NIS) and deck contaminants, including bioaccumulative contaminants of concern (BCC). In the EEA, BCCs are divided into two types: those designated for elimination by various international, Federal, and State programs and those designated for reduction by U.S. permit and cleanup programs. For further information on BCCs refer to *Environmental Effects Analyses Guidance* (EPA and DOD, 2000b).

This DAR summarizes the EEA for each category, along with an abbreviated EEA for each of the example control activities. For a detailed discussion of the environmental effects analyses, refer to the EEAR (Navy, 2002c).

5.2 Topside Management Plan Economic Cost Analysis

The TMP economic analysis was conducted to determine incremental costs, which are additional expenses that the Armed Forces would incur as a result of the implementation of UNDS regulatory requirements. Incremental costs include initial and recurring costs. Most of the activities analyzed in the Deck Runoff FIAR are management practices that are currently in place on some or all Armed Forces vessels. For these activities, the incremental cost includes those resources necessary to develop and implement a TMP, which incorporates the existing management practices, as well as any additional activities that may be required to control deck runoff. The incremental cost for new activities would also include the costs to perform topside management practices or activities that would be required over and above current vessel operation. The cost to perform an activity may include: equipment, labor, and material costs. Other vessel-specific incremental costs or personnel impacts that are TMP implementation dependent are not analyzed in this report. The cost analyses are not intended for preparation of budgets or determination of actual costs.

Table 5-1 summarizes the cost of implementing the TMP in the Navy, U.S. Coast Guard, and U.S. Army, while the costs of activities that may be included in the TMP are analyzed in their respective category subsections. Table 5-2 summarizes the life-cycle costs of implementing and maintaining a TMP for the Navy, U.S. Coast Guard, and U.S. Army.

Table 5-1: TMP Implementation Costs

Armed Force	Line Item	Cost
Navy	Initial Start Up	$1,075,000 one time cost
	Two Representatives for the Feedback Loop	$320,000 annually
	Personnel Training	$400,000 annually
U.S. Coast Guard	Initial Start Up	$500,000 one time cost
	Development and Implementation of Policy Doctrine	$100,000 one time cost
	One Representative for the Feedback Loop	$160,000 annually
	Training Needs Analysis	$200,000 one time cost
	Performance Analysis	$200,000 one time cost
	Course Materials	$150,000 one time cost
U.S. Army	Initial Start Up	$100,000 one time cost
	One Representative (1/2 Time) for the Feedback Loop	$50,000 annually

Table 5-2: Summary of TMP Life Cycle Costs

Armed Force	Total Initial Cost ($K)	Total Recurring Cost ($K)	Incremental Cost ($K)
Navy	1,075	8,023	9,098
U.S. Coast Guard	600	2,340	2,940
U.S. Army	100	557	657

5.3 Category Summary: Aircraft Launch and Recovery Equipment

Navy vessels use aircraft launch and recovery equipment (ALRE) during fixed wing aircraft operations. The three systems used during ALRE operations are arresting gear, catapult launchers, and jet blast deflectors.

5.3.1 Summary of Characterization: Aircraft Launch and Recovery Equipment

Arresting gear assists with the recovery of fixed wing aircraft, while catapult launchers and jet blast deflectors help launch fixed wing aircraft. Armed Forces vessels with ALRE are limited to 13 aircraft carriers distributed among four Navy vessel classes (CVN 65, CVN 68, CV 63, and CV 67 Classes).[2] Materials used to maintain the catapults and jet blast deflector enclosures have the potential to enter surrounding waters. The catapult trough enclosure drains present the largest potential for contribution to deck runoff from ALRE. The design and open track slot of the catapult trough can serve as a collection point for all constituents used topside, including aircraft fuel, hydraulic fluid, soot, rain, sea water, and drainage from flight deck washdown evolutions. In addition, the accumulated materials in the barricade stanchion wells and retractable sheave enclosure areas (see Figures 5.1 and 5.2) in the arresting gear also have a potential to enter surrounding waters. These areas can also serve as collection and discharge points for deck runoff; however, most of these discharges occur outside 12 nm during flight operations. The contribution of deck runoff constituents by these three systems is described in subsections 5.3.1.1 through 5.3.1.3.

5.3.1.1 Arresting Gear (Operation and Maintenance)

The arresting gear system is designed to help fixed wing aircraft land aboard ship at sea by providing rapid deceleration after being caught by aircraft tail hooks (see Figures 5.1 and 5.2). The arresting gear system requires arresting gear grease (MIL-PRF-81322F), Grikote 31EP

2 *Amphibious assault ships (LHD 1 and LHA 1 Classes) carry AV-8B Harrier aircraft. These fixed wing aircraft are vertical and short take-off and landing (V/STOL) capable and do not require catapults or arresting gear.*

lubricating oil (no military specification), anti-seize compound (A-A-59313), and dry-cleaning solvent (MIL-PRF-680, Type III) for lubrication and cleaning. Residual amounts of these lubricants and solvents may become trapped in the rough deck surface and subsequently contribute to deck runoff, with the majority discharged outside 12 nm. Table 5-3 provides a list of material that may be discharged. The quantity of these materials could not be determined due to the high variability of use on arresting gear (Wenzel, *et al.*, 2001a).

Figure 5.1: Arresting Gear

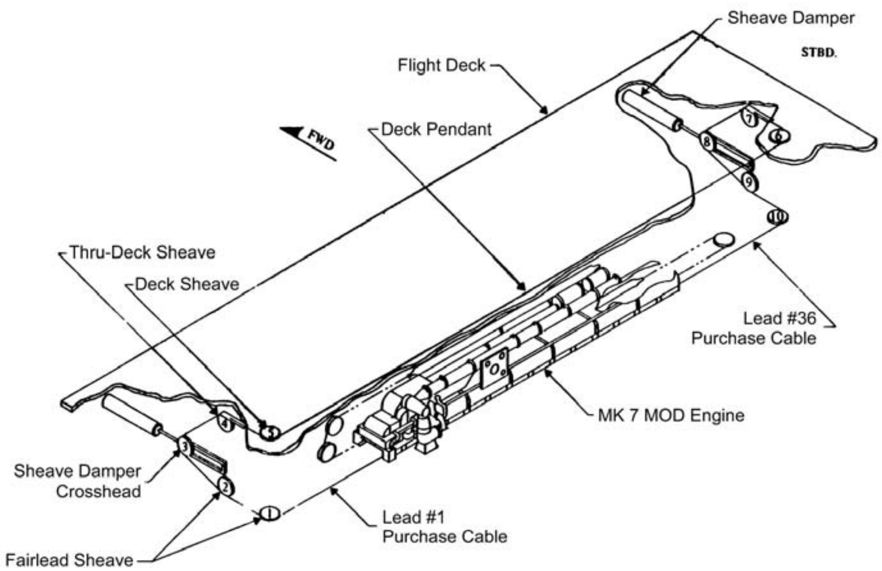

Figure 5.1: The cross deck pendant arresting wires are located on the flight deck. The aircraft tail hook engages one of these four wires. Each cross deck pendant is engaged to a purchase cable which is led from the arresting gear engine up to the flight deck by a series of grooved pulleys called sheaves. The cutaway diagram shows the arresting gear engine, the system of pulleys, and the cross deck pendant. (Image courtesy FAS Military Analysis Network.)

Figure 5.2: Arresting Gear

Figure 5.2: Arresting Gear showing retractable deck sheave housing (U.S. Navy photograph by H. Dwain Willis.)

Table 5-3: Potential Discharge Materials for Arresting Gear

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Arresting Gear Grease (e.g., Mobilgrease 28) (MIL-PRF-81322F)	Unknown	Synthetic oils	—	> 70	Unknown	Unknown
		Additives	—	< 30	Unknown	Unknown
		Sodium nitrite	7632000	Unknown	Unknown	Unknown
Lubricating Oil (Grikote 31EP)	1.7E+03	Petroleum hydrocarbons	—	Unknown	Unknown	Unknown
Anti-seize Compound (A-A-59313)	Unknown	Zinc dust	7440666	42	Unknown	Reduction
		Petroleum grease	8009038	58	Unknown	Unknown
Dry Cleaning Solvent 6850-00-274-5421 (MIL-PRF-680 Type III)	Unknown	High purity hydrocarbon solvents	64771728	100	Unknown	Unknown

BCC = bioaccumulative contaminant of concern
*Note: Information was obtained from military specifications for each material used on the arresting gear. In many cases, different compounds conform to the listed military specification, each having its own material safety data sheet.

5.3.1.2 Catapult Operations

Aircraft carriers are equipped with four steam-powered catapults (see Figure 5.3). Each catapult consists of a catapult slot, a control system, and launching and retraction engines. A drainage system collects fluids from these engines along with deck runoff and discharges them near the waterline. This system consists of a trough directly under the catapults to collect the fluids and drainage lines, equipped with duplex strainers, that discharge overboard near the waterline (Wenzel, *et al.,* 2001a).

Fixed wing aircraft are not launched inside 12 nm; however, carriers must conduct no-load catapult test launches inside 12 nm before any deployment and after major overhaul and repairs, to ensure safe catapult operation. Constituents in the catapult troughs can originate from 120-grade lubricating oil (SAE J1899), MIL-PRF-680 Type III dry solvent, and high temperature grease (DOD-G-85733). Table 5-4 provides a list of material that may be discharged. The quantity of these materials could not be determined due to the high variability regarding their use during catapult operations (Wenzel, *et al.,* 2001a).

Figure 5.3: Aircraft Carrier Flight Operations

Figure 5.3: Four F/A-18 *Hornets* wait to launch from the bow catapults of the *USS Enterprise*. The figure shows the bow catapults with jet blast deflectors raised. The catapult has a 4-inch slot opening in the deck. The catapult trough lies beneath this slot. Each catapult includes two steam cylinders fitted with pistons that provide the motive force for the system. These pistons are fitted to a shuttle that is connected to the nose landing gear of the aircraft. Each catapult trough is approximately 5 ft wide, almost 4 ft deep, and approximately 340 ft long. (Navy photograph by Benjamin D. Olvey.)

Table 5-4: Potential Discharge Material for Catapult Operation

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Grease (Bel Ray HT) 9150-01-145-1259 DOD-G-85733	3.3E+3	Antimony compound	—	< 1	< 3.3E+1	None
		Molybdenum compound, insoluble	—	10	3.3E+2	None
		Graphite, natural	7782425	5	1.7E+2	None
Aeroshell Grade 120 9150-00-753-4937 SAE J1899	6.4E+3	Mineral oil/ petroleum distillates	—	40 to 50	2.6E+3 to 3.2E+3	Unknown
		Hydrotreated oil	—	50 to 60	3.2E+3 to 3.9E+3	Unknown
Dry Cleaning Solvent 6850-00-274-5421 MIL-PRF-680 Type III	Unknown	High purity hydrocarbon solvents	—	100	Unknown	Unknown

*Note: Potential Discharge Volume varies with operational speed and frequency, temperature, and weather conditions.

5.3.1.3 Jet Blast Deflectors (Operation and Maintenance)

Jet blast deflectors are sections of an aircraft carrier flight deck that are raised prior to an aircraft launch to deflect the high velocity exhaust and heat from aircraft jet engines (see Figure 2.3). The sources of deck runoff constituents from jet blast deflectors include lubricating oil (NSN 9150-01-432-0511), a petroleum-based water-resistant general purpose grease (MIL-G-23549; NSN 9150-00-823-8047), anti-seize compound (A-A-59313; NSN 8030-00-292-1102); dry cleaning solvent (MIL-PRF-680 Type III), and accumulated jet exhaust soot. Constituents from jet blast deflectors can contribute to deck runoff after heavy rainfall. Table 5-5 is a list of material that may be discharged. The use of the lubricating oil was estimated based on shipboard observations and conversations with crewmembers responsible for jet blast deflectors. The quantity of the other materials could not be determined due to the high variability regarding their use or generation rate (Wenzel, *et al.*, 2001a).

Table 5-5: Potential Discharge Material for Jet Blast Deflectors

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Grease (GP) 9150-00-823-8047 MIL-G-23549	Unknown	Petroleum hydrocarbons	—	Unknown	Unknown	Unknown
Oil, Lubricating 9150-01-432-0511 (No mil spec)	984	Unknown	—	Unknown	Unknown	Unknown
Anti-seize Compound 8030-00-292-1102 A-A-59313	Unknown	Zinc	7440666	58	Unknown	Reduction
		Petrolatum	—	42	Unknown	Unknown
Jet Exhaust Soot	Unknown	Unknown	—	Unknown	Unknown	Unknown
Dry Cleaning Solvent 6850-00-274-5421 MIL-PRF-680 Type III	Unknown	High purity hydrocarbon solvents	—	100	Unknown	Unknown

*Note: Potential discharge volume varies with operational speed and frequency, temperature, and weather conditions. A full analysis was not conducted on jet exhaust soot, but may contain carbonaceous material, sulfates, and by-products of incomplete combustion of JP-5.

5.3.2 Summary of Feasibility and Environmental Effect Analyses: Aircraft Launch and Recovery Equipment

The TMP performance objective for ALRE is for the vessel's responsible party to prevent the discharge of oils, greases, solvents, soot, and other materials associated with ALRE that may negatively impact water quality. Activities that assist the vessel in meeting the performance objective were analyzed in both the FIAR and EEAR.

Feasibility: ALRE

The feasibility analysis determined that there were no significant personnel or cost impacts for the example ALRE activities.

Environmental Effects: ALRE

The EEAR determined that the sludge from catapult systems may cause sheens and floating material while pierside, which results in a failure of the narrative WQC endpoints for color, floating materials, and oil and grease. Other materials used, such as high temperature grease, dry cleaning degreaser, and anti-seize compound could also contribute to the total amount of oil and grease released. Soot particles from the jet blast deflectors can potentially contribute floating and settable material and suspended solids to deck runoff.

Table 5-6 provides a summary of the example activities that were analyzed in the FIAR and EEAR. For a more in-depth discussion on the analyses refer to the FIAR and EEAR.

Table 5-6: Summary of Analysis: Aircraft Launch and Recovery Equipment

Examples of Activities	Feasibility	Environmental Effects
Minimizing Catapult Test Launches In Port -Reduces test launches in port. -Reduces discharge of oil and grease while in port	-Currently performed -Only cost is incorporation into the TMP	-Within 12 nm, reduces likelihood of floating material, sheens (from oil and grease), suspended solids, and turbidity. May increase loading of such materials beyond 12 nm from shore. -Constituents that were discharged within 12 nm are displaced to beyond 12 nm.
Cleaning and Stowing ALRE Before Transiting within 12 nm -Cleans/stows equipment outside 12 nm -Reduces discharge of oil, grease, and anti-seize compounds within 12 nm.	-Currently performed -Only cost is incorporation into the TMP	- Within 12 nm, reduces likelihood of floating material, sheens (from oil and grease), suspended solids, and turbidity. May increase loading of such materials beyond 12 nm from shore. -Constituents that were discharged within 12 nm are displaced to beyond 12 nm.
Use an Environmentally Compliant Lubricant for Catapults or Other Equipment Associated with ALRE -Mandatory lubricant change -Provides similar lubricating capabilities -Reduces discharge of petroleum-based oil	-Environmentally compliant lubricant costs $513 per 55 gallons versus $175 per 55 gallons for the conventional lubricant (Alexander, 2001) -Currently implemented through an Engineering Change	-Reduces likelihood of sludge and floating material

5.4 Category Summary: Buoy Maintenance

The Coast Guard is the only branch of the Armed Forces that retrieves, maintains, and resets navigational buoys.

5.4.1 Summary of Characterization: Buoy Maintenance

The majority of navigational buoys are located in inland and coastal waters inside 12 nm. The vessels range in size from the 49-ft Boat Utility Stern Loading (BUSL 49) to the 225-ft Seagoing Buoy Tender (WLB 225). There is only one process under this category, maintenance and preservation of buoys. Navigational buoys range in design from unpainted plastic buoys to steel ocean buoys. When deployed, navigational buoys are connected to concrete block sinkers by iron chains. Sinkers anchor the buoys in place. Vessels that maintain buoys are equipped with cranes and cross-deck winches that haul buoys aboard. Inspection, cleaning, and maintenance commence once the buoys are onboard and secured to the tender's buoy deck. Coast Guard standards require each buoy be inspected and serviced, if needed, at least every two years.

5.4.1.1 Maintenance and Preservation of Buoys

During buoy cleaning, crewmembers use scrapers and high-pressure washers to remove sediment, biofouling material, and rust. Paint chips can be generated when biofouling material is removed and when painted surfaces are prepared for touch-up painting. No chemical paint removers are used on navigational buoys. Major re-painting and maintenance is done at shore facilities, with only touch-up painting conducted during onboard inspections (Wenzel, *et al.*, 2001a). Biofouling material, removed from buoys, is discharged in the same "ecological area" (as defined in the EEAR); therefore, the potential to transport NIS is very small (Volpe, 2002). Table 5-7 provides a list of material that may be discharged. The quantity of materials discharged during buoy operations could not be determined due to the high variability of buoy biofouling.

Table 5-7: Potential Discharge Materials for Buoy Operations

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Paint chips/debris	1.0E+02 (estimated)	Copper as cuprous oxide	7440508	47	5.1E+01	Reduction
		Zinc as zinc oxide	7440666	15	1.6E+01	Reduction

5.4.2 Summary of Feasibility and Environmental Effect Analyses: Buoy Maintenance

The TMP performance objectives for buoy maintenance are for the vessel's responsible party to 1) prevent the discharge of rust, paint chips, paint drips, cleaning compounds, and other materials associated with buoy maintenance that may negatively impact water quality and 2) to prevent transport of non-indigenous species with fouling material and sediment released during buoy maintenance operations.

Feasibility: Buoy Maintenance
The feasibility analysis determined that there were no significant personnel or cost impacts for the example buoy maintenance activities.

Environmental Effects: Buoy Maintenance
Buoy maintenance releases suspended solids and settable material, which may cause turbidity and affect the transparency and color of the receiving waters. With the exception of paint chips and rust, all suspended and settleable materials discharged by buoy handling activities that take place while on site are indigenous to the receiving waters. Due to the high concentration of copper and zinc used in ablative antifouling paints, the discharge may exceed numeric WQC for either metal in the vicinity of the discharge.

During typical buoy maintenance operations, buoy tenders remain within the same ecological area of the buoy station. Consequently, biofouling organisms discharged during these buoy handling activities are indigenous to the receiving waters. For these analyses, an ecological area was considered to be a continuous aquatic system not impeded by physiographic or ecological barriers (e.g., levees, dams, gates, salinity, temperature, depth) that would prevent the natural transport and dispersal of aquatic biota by either active organism locomotion or drifting with current or tidal flows. Therefore, marine organisms and sediments removed from the surface of the buoys are returned to their native environment.

Table 5-8 provides a summary of the example activities that were analyzed to control deck related to buoy maintenance. For a more in-depth discussion on the analyses refer to the FIAR and EEAR.

Table 5-8: Summary of Analysis: Buoy Maintenance

Examples of Activities	Feasibility	Environmental Effects
Using high pressure washers -Washes buoys with 3,000 psi spray	-Currently performed -Only cost is incorporation into the TMP	-Reduces discharge of paint chips and rust
Conducting only minor buoy repairs underway -Major repairs conducted ashore	-Currently performed -Only cost is incorporation into the TMP	- Reduces paint chips rust, and paint drips
Rinsing biofouling material and sediment from buoys -Discharges biofouling material and sediment in the immediate vicinity of the buoy position	-Currently performed -Only cost is incorporation into the TMP	-Reduces the potential to transport and introduce non-indigenous species

5.5 Cleaning Activities/General Housekeeping

All Armed Forces vessels perform some method of cleaning activities/general housekeeping.

5.5.1 Summary of Characterization: Cleaning Activities/General Housekeeping

The type and extent of cleaning and general housekeeping activities depend largely on vessel class and area of operation. The sources of water are freshwater and seawater from the vessel's firemain system. For evaluation purposes, cleaning and general housekeeping activities were divided into five processes: (1) aircraft washdowns; (2) electronic intelligence/navigation systems maintenance; (3) equipment and vehicle washdowns; (4) exterior topside surfaces washdowns; and (5) firemain systems. These five processes are described in subsections 5.5.1.1 through 5.5.1.5.

5.5.1.1 Aircraft Washdowns

Aircraft washdowns include cleaning the exterior surfaces and engines of fixed wing and rotary wing aircraft. Aircraft washdowns remove dirt, salt, hydraulic fluid (MIL-PRF-83282D), lubricating oil (MIL-PRF-23699F), and greases (MIL-PRF-23827C and MIL-PRF-81322F) (Wenzel, *et al.*, 2001a).

Fixed Wing Aircraft

The exterior surfaces of fixed wing aircraft are cleaned with freshwater and aircraft cleaning compound (MIL-C-85570C Type II) (Wenzel, *et al.*, 2001a).

Rotary Wing Aircraft

A complete freshwater washdown of Navy rotary wing aircraft is performed every seven days, with most washdowns conducted outside 12 nm (Wenzel, *et al.*, 2001a; Wenzel, 2001b; Wenzel, 2001c). The washdown solution consists of a mixture of aircraft cleaning compound (MIL-C-85570C Type II) and freshwater. Coast Guard vessels with rotary wing aircraft, operate both inside and outside 12 nm. Coast Guard rotary wing aircraft are washed daily when underway with a 50/50 mixture of VCI-415 aircraft cleaning compound and freshwater (U.S. Coast Guard, 1999; U.S. Coast Guard, 2000).

Fixed Wing and Rotary Wing Aircraft Engines

Fixed wing and rotary wing aircraft engines are cleaned with MIL-C-87937D cleaner or gas path MIL-C-85704C Type I or IIA cleaner, both of which are mixed with freshwater. Frequency of engine wash with gas path cleaner depends on the type of aircraft and vessel location (Wenzel, *et al.*, 2001a). Rotary wing aircraft engines and rotors are rinsed with freshwater after each flight (Wenzel, *et al.*, 2001a).

The quantity of these materials could not be determined due to the high variability regarding their use during aircraft washdowns. Table 5-9 provides a list of material that may be discharged.

Table 5-9: Potential Discharge Materials for Aircraft Washdown

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Aircraft Cleaning Compound, MIL-C-87937D	Unknown	2-Butoxyethanol	111726	1 to 5	Unknown	None
		Cyclohexanol	108930	1 to 5	Unknown	None
		Aromatic hydrocarbons	64742945	20 to 40	Unknown	Unknown
Aircraft Cleaning Compound, MIL-PRF-85570C, Type II	Unknown	Dipropylene glycol methyl ether	34590948	10	Unknown	None
		Morpholine	110918	0.5	Unknown	None
		Ethoxylated nonylphenol	—	Unknown	Unknown	None
		Alkanolamide	—	Unknown	Unknown	None
Hydraulic Fluid, MIL-PRF-83282D	Unknown	Synthetic hydrocarbon based oil	—	> 65	Unknown	Unknown
		Ester based lubricant	—	< 35	Unknown	Unknown
Lubricating Oil, MIL-PRF-23699FF	Unknown	Polyol esters	—	100	Unknown	Unknown
Grease, MIL-PRF-23827C	Unknown	Synthetic ester	—	75 to 85	Unknown	None
		Lithium 12 hydroxystearate	7620771	10 to 15	Unknown	None
		Antimony dialkyldithiocarbamate	15890252	1 to 2	Unknown	None
		p,p'-Dioctyldiphenylamine	101677	1	Unknown	None
Grease, MIL-PRF-81322F	Unknown	Mixture of paraffinic, naphthenic, and aromatic hydrocarbons	—	Unknown	Unknown	None
Gas Path Cleaner, MIL-C-85704C	Unknown	Dipropylene glycol methyl ether	34590948	10	Unknown	None
		Hexylene glycol	107415	10	Unknown	None
		Heavy aromatic naphtha	64742945	Unknown	Unknown	None
		Triethanolamine	102716	Unknown	Unknown	None
		Nonylphenol polyethoxate	9016459	Unknown	Unknown	None

Note: Potential discharge volume are unknown because they depend on the type of aircraft being washed, the quantity being washed, and amount of dirt on the aircraft.

5.5.1.2 Electronic Intelligence/Navigation Systems Maintenance

Operation of electronic intelligence/navigation systems are self-contained, therefore, there is minimal contribution to deck runoff. Surfaces of the electronic intelligence/navigation systems are cleaned with freshwater and a small amount of cleaning compound (Simple Green™), which has the potential to contribute to deck runoff. Table 5-10 provides a list of material that may be discharged. The quantity of the material in the discharge was determined based on shipboard observations and conversations with crewmembers responsible for electronic intelligence/navigation systems maintenance (Wenzel, *et al.*, 2001a).

Table 5-10: Potential Discharge Material for Electronic Intelligence/Navigation Systems Maintenance

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Cleaning Compound (Simple Green™)	Negligible	2-butoxyethanol	111762	<6	Unknown	Unknown

5.5.1.3 Equipment and Vehicle Washdowns

Most Navy and Coast Guard equipment and vehicle washdowns are performed outside 12 nm, however some residue remains trapped in the rough deck surface and may contribute to deck runoff inside 12 nm (Wenzel, *et al*., 2001a).

On U.S. Army vessels, vehicles are normally part of the vessel's cargo (e.g., tanks, and Humvees®) and are washed frequently with freshwater (inside as well as outside 12 nm) to prevent the accumulation of salt from sea spray. The constituents from equipment and vehicle washdowns that contribute to deck runoff include salt residue, dirt, oil, grease, and cleaning compounds. Specific materials include: MIL-PRF-2104G and MIL-PRF-2105E lubricating oil, MIL-G-10924G automotive and artillery grease, MIL-PRF-46170C fire resistant hydraulic fluid, MIL-G-23549 general purpose grease, MIL-G-18458B wire rope grease, and SAE AS8660 silicone compound. The quantity of these materials could not be determined due to the high variability among vessels regarding their use. Table 5-11 provides a list of material that may be discharged.

Table 5-11: Potential Discharge Materials for Equipment and Vehicle Washdowns

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Lubricating Oil, MIL-PRF-2104G	Unknown	Petroleum hydrocarbons	—	Unknown	Unknown	Unknown
Lubricating Oil MIL-PRF-2105E	Unknown	Petroleum hydrocarbons	—	Unknown	Unknown	Unknown
Wire Rope Grease, MIL-G-18458B	Unknown					
		Phosphorous (Yellow)	7723140	Unknown	Unknown	None
		Petroleum carriers	—	Unknown	Unknown	Unknown
General Purpose Grease, MIL-G-23549	Unknown	Petroleum hydrocarbons	—	Unknown	Unknown	Unknown
Automotive and Artillery Grease, MIL-G-10924G	Unknown	Petroleum hydrocarbons	—	100	Unknown	Unknown
Fire Resistant Hydraulic Fluid, MIL-PRF-46170C	Unknown	Synthetic hydrocarbon base oils	68649127	60 to 65	Unknown	Unknown
		Synthetic esters	—	25 to 30	Unknown	Unknown
		Barium dinonylnaphthalene sulfonate	25619561	2 to 3	Unknown	None
		Tricresyl phosphate	1330785	1 to 2	Unknown	None
Silicone Compound, SAE AS8660	Unknown	Dimethylpolysiloxane	63394025	90	Unknown	None
		Silica	112945525	10	Unknown	None

5.5.1.4 Exterior Topside Surface Washdowns

Deck washdowns are frequently performed on all vessel classes. The type, frequency, and magnitude of the washdowns depend on the vessel class and area of operation. Washdowns can be conducted while pierside or underway. Washdown frequency can vary due to operational area, vessel mission, and type.

Expected constituents in washdown wastewaters include salt, dirt, rust, hydraulic fluid (e.g., MIL-PRF-83282D), grease (e.g., MIL-PRF-81322F), fuel, paint chips, human debris (waste and clothing from onboard migrants), cleaning compounds (e.g., Simple Green™, general purpose detergent (MIL-D-16791G), gas path cleaner (MIL-C-85704C), Brite Crème™, Zip Wax Car Wash™, B&B 88 flight deck cleaner), and jet exhaust soot. Unknown amounts of water (freshwater or seawater), cleaning compounds, and residue deposited on the deck are discharged overboard during deck washdowns (Wenzel, *et al.*, 2001a). Table 5-12 provides a list of material that may be discharged.

Table 5-12: Potential Discharge Materials for Exterior Topside Surface Washdowns

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Cleaning Compound (Simple Green™)	2.0E+05 (estimated)	2-Butoxyethanol	111762	< 6	< 1.2E+04	None
Cleaning Compound (Brite Creme™)	9.0E+01 (estimated)	Unknown	—	Unknown	Unknown	Unknown
Cleaning Compound (Zip Wax Car Wash™)	1.5E+04 (estimated)	Unknown	—	Unknown	Unknown	Unknown
Flight Deck Cleaner (B&B 88)	Negligible	Unknown	—	Unknown	Negligible	Unknown
Degreaser, MIL-D-16791G	Negligible	Unknown	—	Unknown	Negligible	Unknown
Hydraulic Fluid, MIL-PRF-83282D	Negligible	Synthetic hydrocarbon based oil Ester based lubricant	— —	> 65 < 35	Negligible Negligible	Unknown Unknown
Grease, MIL-PRF-81322F	Negligible	Mixture of paraffinic, naphthenic and aromatic hydrocarbons	—	Unknown	Negligible	Unknown
Gas Path Cleaner, MIL-C-85704C	Negligible	Dipropylene glycol methyl ether	34590948	10	Unknown	Unknown
		Hexylene glycol	107415	10	Unknown	Unknown
		Heavy aromatic naphtha	64742945	Unknown	Unknown	Unknown
		Triethanolamine	102716	Unknown	Unknown	Unknown
		Nonylphenol polyethoxate	9016459	Unknown	Unknown	Unknown
Human Waste/Debris	Unknown	Unknown	—	Unknown	Unknown	Unknown
Jet Exhaust Soot	Unknown	Unknown	—	Unknown	Unknown	Unknown

5.5.1.5 Firemain Systems (For Use in Exterior Washdowns)

Firemain systems use saltwater supplied at various pressures depending on vessel class. This system is used during exterior topside surface washdown evolutions on some vessels. Firemain discharges can contribute contaminants to deck runoff. However, firemain discharges and their constituents are addressed as a separate discharge in UNDS.

5.5.2 Summary of Feasibility and Environmental Effect Analyses: Cleaning Activities/ General Housekeeping

The TMP performance objective for cleaning activities/general housekeeping is for the vessel's responsible party to prevent the discharge of cleaning compounds, hydraulic fluids, oils, fuels, greases, dirt, salts, soot, and other materials associated with cleaning activities/general housekeeping that may negatively impact water quality.

Feasibility: Cleaning Activities/ General Housekeeping
The feasibility analysis determined that there were no significant personnel or cost impacts for the example cleaning activities/general housekeeping activities.

Environmental Effects: Cleaning Activities/ General Housekeeping
Cleaning and general housekeeping activities can produce deck runoff containing traces of oil, grease, and hydraulic fluids that may cause waters near the vessel to fail narrative (oil and grease, and color) WQC.

Table 5-13 provides a summary of the example activities that were analyzed in the FIAR and EEAR. For a more in-depth discussion refer to the FIAR and EEAR.

Table 5-13: Summary of Analysis: Cleaning Activities/General Housekeeping

Examples of Activities	Feasibility	Environmental Effects
Minimize Cleaning for Aircraft, Exterior Topside Surfaces, Equipment, and Vehicles within 12 nm -Conduct cleaning outside 12 nm where possible -Reduces discharge of detergents, and oil and grease	-Currently performed -Only cost is incorporation into the TMP	-Within 12 nm, reduces the likelihood of floating materials, sheens (from oil and grease), settleable materials, suspended solids, and turbidity. May increase loading beyond 12 nm from shore. -Constituents that were discharged within 12 nm are displaced to beyond 12 nm.
Using a Vacuum to Remove Aircraft Washwater Generated Outside 12 nm -Collect aircraft washwater with a vacuum to prevent constituents being trapped in the rough deck surface -Reduces discharge of dirt, oil and grease	-Currently performed on some vessels, for vessels on which this practice is performed, the only cost is incorporation into the TMP -Unit prices for one vacuum and related equipment range from $150-$650	-Within 12 nm, reduces the likelihood of floating materials, sheens (from oil and grease), settleable materials, suspended solids, and turbidity. May increase loading beyond 12 nm from shore. -Constituents that were discharged within 12 nm are displaced to beyond 12 nm.
Using a Flight Deck Scrubber -Use rider or walk-behind scrubber to clean decks -Reduces debris, dirt, oil and grease	-Currently performed on some vessels, those vessels only cost is incorporation into the TMP -Unit prices for one rider-type scrubber range from $53K-$55K -Unit prices for one walk-behind scrubber range from $8K-$10K	-Reduces the likelihood of floating materials, sheens (from oil and grease), settleable materials, suspended solids, and turbidity

5.6 Category Summary: Deck Machinery and Weapons Lubrication

Most Armed Forces vessels have some type of deck machinery or fixed weapons systems that require lubrication.

5.6.1 Summary of Characterization: Deck Machinery and Weapons Lubrication

Lubrication of deck machinery and weapons generates traces of oil, grease, and hydraulic fluids that can become trapped in the rough deck surface and contribute to deck runoff from rain and green water (i.e., seawater that comes over the bow during heavy weather). Lubrication of deck machinery and weapons is a common practice on most Armed Forces vessels and therefore it is a major source of oil and grease constituents in deck runoff. Vessels operating in warm climates are more prone to grease falling to the deck than vessels operating in cooler climates because grease has a greater viscosity in cooler temperatures and is generally less likely to drip or get washed off by water.

For evaluation purposes, deck machinery and weapons lubrication activities were divided into nine major processes: (1) aircraft elevators; (2) buoy handling systems; (3) fire assist vehicles; (4) mine handling systems; (5) recovery, assist, securing, and traversing (RAST) systems; (6) ships' boats and launching systems; (7) stores handling systems; (8) towing and mooring systems; and (9) weapons systems. These nine processes are discussed in subsections 5.6.1.1 through 5.6.1.9.

5.6.1.1 Aircraft Elevators (Operation and Maintenance)

Aircraft elevators are used to move aircraft from the hangar deck to the flight deck. Elevator cables, rails, and stanchions are lubricated using DOD-G-24508A (a general purpose grease based on a synthetic oil), MIL-G-23549, MIL-G-24139A (petroleum based water-resistant greases), and MIL-G-18458B (Navy, 1999b; Wenzel, *et al.*, 2001a). These elevator components are exposed to the weather where the rain and wind cause these lubricants to fall to the deck or into the receiving water, contributing to deck runoff. The potential volume of general-purpose grease, multipurpose grease, and wire rope grease is based upon shipboard observations and conversations with crewmembers responsible for aircraft elevators. Table 5-14 provides a list of material that may be discharged. The quantity of DOD-G-24508, grease discharged could not be determined due to the high variability regarding its use on aircraft elevators (Wenzel, *et al.*, 2001a).

Table 5-14: Potential Discharge Materials for Aircraft Elevators

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
General Purpose Grease, MIL-G-23549	1.7E+03	Petroleum Hydrocarbons	—	Unknown	Unknown	Unknown
Multipurpose Grease, MIL-G-24139A	9.6E+01	Petroleum Hydrocarbons	—	Unknown	Unknown	Unknown
Wire Rope Grease, MIL-G-18458B	1.4E+02	Phosphorous (yellow)	7723140	Unknown	Unknown	None
		Petroleum carriers	—	Unknown	Unknown	Unknown
Grease, DOD-G-24508A	Unknown	Synthetic hydrocarbon	—	> 73	Unknown	Unknown
		Sodium nitrite	7632000	< 1.5	Unknown	None

5.6.1.2 Buoy Handling Systems (Operation and Maintenance)

Buoy handling systems are located on Coast Guard buoy tenders. Buoy tenders are equipped with cranes and cross-deck winches to haul on deck and deploy navigational buoys. The wire rope on the cranes and cross-deck winches is lubricated with MIL-G-18458B. MIL-H-17672D hydraulic fluid is used in cranes and cross-deck winches. Incidental drips of grease and hydraulic fluid can deposit oil and grease constituents on the deck. Although the deposited grease and hydraulic fluid is immediately cleaned, some residue remains trapped in the rough deck surfaces and may contribute to deck runoff both inside and outside 12 nm (Wenzel, *et al.*, 2001a). The potential discharge volume for wire rope grease was estimated from shipboard observations and conversations with crewmembers responsible for buoy handling equipment. Table 5-15 provides a list of material that may be discharged. The quantity of hydraulic fluid could not be determined due to the high variability among vessels and systems of the fluid leaking onto the deck (Wenzel, *et al.*, 2001a).

Table 5-15: Potential Discharge Materials for Buoy Handling

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Wire Rope Grease, MIL-G-18458B	1.4E+02	Phosphorous (yellow)	7723140	Unknown	Unknown	None
		Petroleum carriers	—	Unknown	Unknown	Unknown
Hydraulic Fluid, MIL-H-17672D	Unknown	Petroleum distillates	—	Unknown	Unknown	Unknown

5.6.1.3 Fire Assist Vehicles (Operation and Maintenance)

The operation and maintenance of fire assist vehicles do not have the potential to contribute to deck runoff because maintenance is performed below decks (Wenzel, *et al.*, 2001a).

5.6.1.4 Mine Handling Systems (Operation and Maintenance)

Mine handling equipment includes: cable reel assemblies, winch assemblies, winch control stations, outrigger booms, cranes, mine tensioner payout systems, and a mine neutralization system (MNS) remotely operated vehicle. The equipment is lubricated with MIL-G-24139A grease and MIL-PRF-2105E oil. Hydraulic fluid (MIL-H-17672D) also can leak from the system onto the deck. Although the deposited grease and hydraulic fluid is immediately cleaned, some residue remains trapped in the rough deck surfaces and may contribute to deck runoff both inside and outside 12 nm (Wenzel, *et al.*, 2001a). Table 5-16 provides a list of material that may be discharged. The quantity of grease, lubricating oil, and hydraulic fluid could not be determined due to the high variability of leaks among vessels.

Table 5-16: Potential Discharge Materials for Mine Handling Systems

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Multipurpose Grease, MIL-G-24139A	Unknown	Petroleum hydrocarbons	—	Unknown	Unknown	Unknown
Hydraulic Fluid, MIL-H-17672D	Unknown	Petroleum distillates	—	Unknown	Unknown	Unknown
Lubricating Oil, MIL-PRF-2105E	Unknown	Petroleum hydrocarbons	—	Unknown	Unknown	Unknown

5.6.1.5 Recovery, Assist, Securing, and Traversing Systems (Operation and Maintenance)

RAST systems assist SH-60B helicopters in landing on vessels during rough weather. The cables and track for the motor require lubrication using MIL-PRF-81322F grease (see Figure 5.4) (Wenzel, *et al.*, 2001a). Although the grease used is inside the track, the potential exists for grease to be incorporated into the non-skid surface and contribute to deck runoff. The quantity of grease that enters surrounding waters could not be determined (Wenzel, *et al.*, 2001a). Table 5-17 provides a list of material that may be discharged.

Figure 5.4: Cross Section of a Navy RAST System

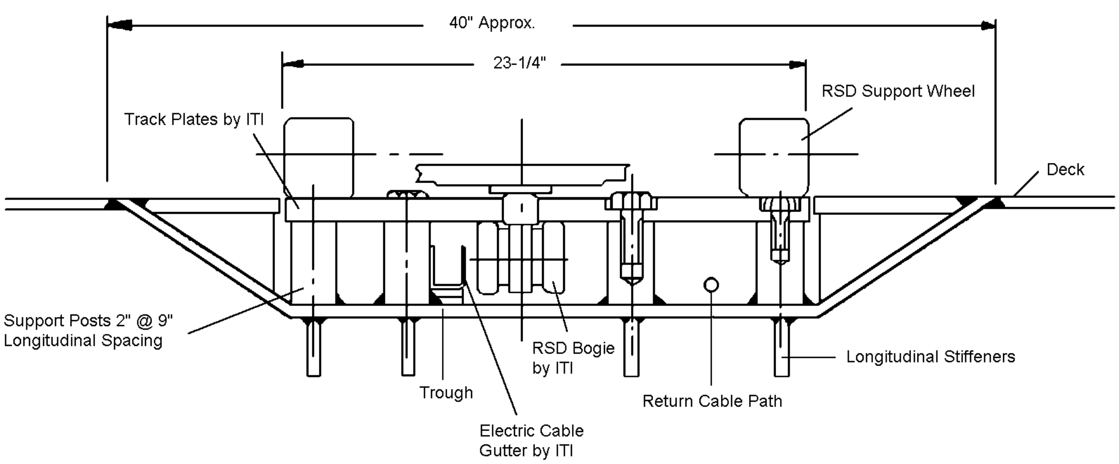

Figure 5.4: The figure shows the trough for Navy RAST System. The trough is approximately 2 ft wide and 9 in deep. It acts as a guide for the Rapid Securing Device (RSD), and contains cables that are used to bring the helicopter to the deck and to move the helicopter along the track into the hangar. (Courtesy Indal Technologies Inc.)

Table 5-17: Potential Discharge Materials for Recovery, Assist, Securing and Traversing (RAST) System

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading	Any BCCs Present?
Grease, MIL-PRF-81322F	Unknown	Mixture of paraffinic, naphthenic, and aromatic hydrocarbons	—	Unknown	Unknown	Unknown

5.6.1.6 Ship's Boats and Launching Systems (Operation and Maintenance)

All ships carry boats that are used for various support activities. A ship's boats are generally launched and recovered using cranes or davits. Boats are connected to these lifting systems by wire rope that is lubricated using various military standard greases including MIL-G-18458B and MIL-G-23549 (Navy, 1999b; Wenzel, *et al.*, 2001a). The cables are cleaned with MIL-PRF-680 Type III dry cleaning solvent, Simple Green^{TM}, and JP-5 fuel, which is a middle distillate specially blended kerosene. Hydraulic fluid (e.g., MIL-H-17672D) is used in some davit systems. Exposure to the weather causes these lubricants, fluids, and cleaners to fall to the deck and therefore potentially contribute to deck runoff both inside and outside 12 nm.

Boat engines can also be a source of deck runoff constituents. The engines of some of the smaller boats are run periodically on deck to ensure proper function. This operation may deposit fuel (MIL-DTL-5624T and gasoline/oil mixture) and soot onto the deck of the vessel, creating the potential to contribute to deck runoff both inside and outside 12 nm. Small boats are cleaned with general-purpose detergent (MIL-D-16791G) or Simple Green^{TM}. Tables 5-18 and 5-19 provide lists of material that may be discharged. For ships' boats launching systems, the potential discharge volume of cleaning compounds was estimated to be negligible based upon shipboard observations. The quantity of grease, dry cleaning solvent, fuel, and hydraulic fluid could not be determined due to the high variability of leaks among vessels. For ships' boats, the quantity of cleaning compounds was estimated to be negligible based upon shipboard observations. The quantity of fuel, gasoline/outboard mixture, detergent, and soot could not be determined due to the high variability of their use (e.g., fuel, gasoline/outboard mixture, detergent) or generation rate (e.g., soot) (Wenzel, *et al.*, 2001a).

Table 5-18: Potential Discharge Materials for Ships' Boats Launching Systems

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Fuel, MIL-DTL-5624T	Unknown	Kerosene	8008206	100	Unknown	Unknown
Detergent, MIL-D-16791G	Unknown	Nonylphenoxy (ethylenoxy) ethanol	—	> 99	Unknown	None
Gasoline/outboard oil mixture 50:1	Unknown	Unknown	—	Unknown	Unknown	Unknown
Soot from engine combustion	Unknown	Unknown	—	Unknown	Unknown	Unknown
Cleaning Compound (Simple Green™)	Negligible	2-butoxyethanol	111762	< 6	Negligible	None

Table 5-19: Potential Discharge Materials for Ships' Boats

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Wire Rope Grease, MIL-G-18458B	Unknown	Phosphorous (yellow)	7723140	Unknown	Unknown	None
		Petroleum carriers	—	Unknown	Unknown	Unknown
General Purpose Grease, MIL-G-23549	Unknown	Petroleum Hydrocarbons	—	Unknown	Unknown	Unknown
Hydraulic Fluid, MIL-H-17672D	Unknown	Petroleum distillates	—	Unknown	Unknown	Unknown
Dry Cleaning Solvent, MIL-PRF-680 Type III	Unknown	High purity hydrocarbon solvents	—	100	Unknown	Unknown
Cleaning Compound (Simple Green™)	Negligible	2-Butoxyethanol	111762	<6	Negligible	None
Fuel, MIL-DTL-5624T	Unknown	Kerosene	8008206	100	Unknown	Unknown

*A full analysis was not conducted on jet exhaust soot, but may contain carbonaceous material, sulfates, and by-products of incomplete combustion.

5.6.1.7 Stores Handling Systems (Operation and Maintenance)

Stores handling systems are used for underway replenishment (UNREP) to transfer supplies from ship-to-ship or shore-to-ship (see Figure 5.5). Stores handling systems exposed to the weather have the potential to contribute constituents to deck runoff. Greases (MIL-G-24139A and MIL-G-23549) are used to lubricate stores handling equipment including the kingpost assembly, wire ropes, and cable drums (Wenzel, *et al.*, 2001a). Spills are immediately cleaned up, however residual grease has the potential to remain trapped in the rough deck surface and contribute to deck runoff both inside and outside 12 nm. Table 5-20 provides a list of material that may be discharged. The amount of grease could not be quantified due to the high variability of spills among vessels.

Figure 5.5: UNREP Replenishment at Sea (RAS) Kingpost with Sliding Padeye

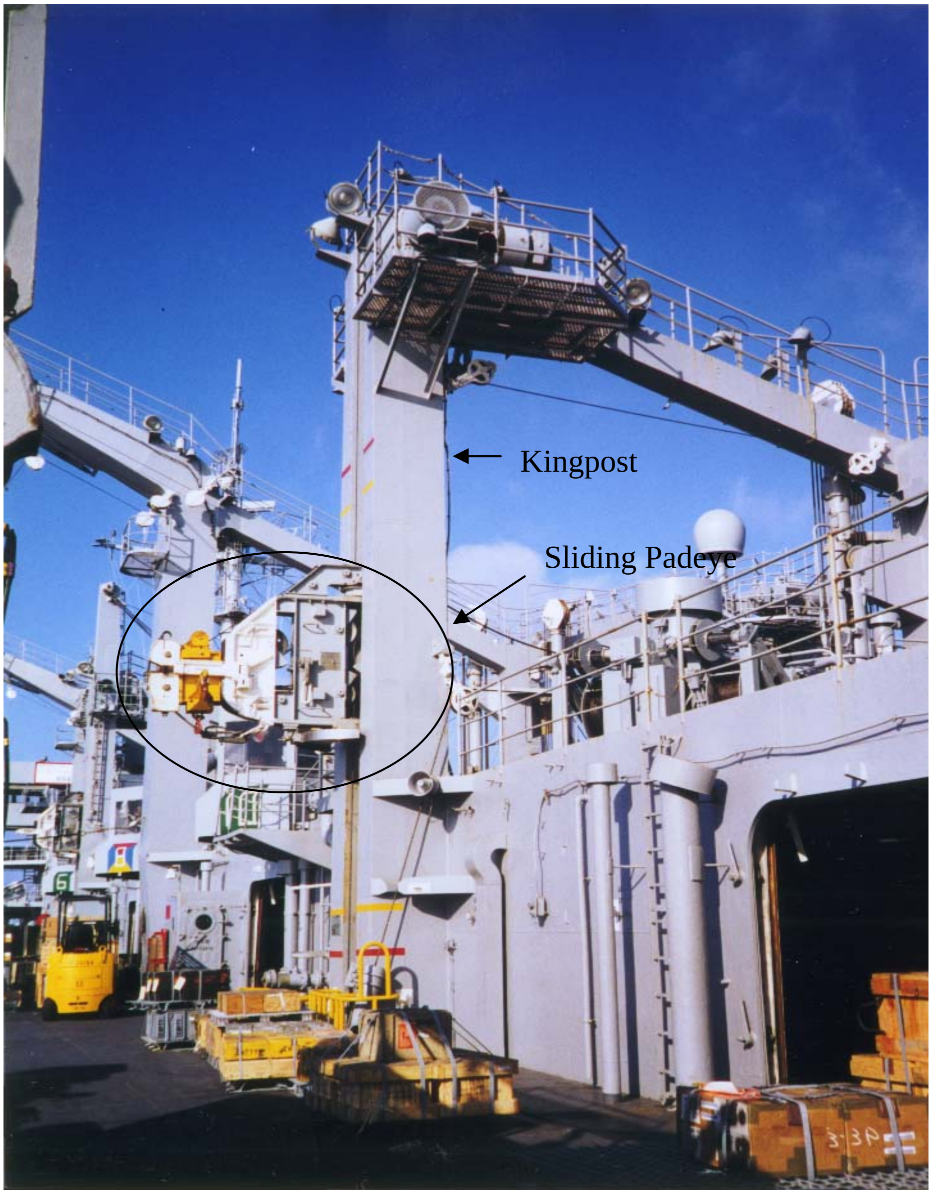

Figure 5.5: UNREP Replenishment At Sea (RAS) Kingpost with sliding padeye on 01 Level on an AOE 3 (Photograph courtesy of Deepak Saha, M. Rosenblatt & Son - an AMSEC LLC Group).

Table 5-20: Potential Discharge Materials for Stores Handling Systems

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Multipurpose Grease, MIL-G-24139A	Unknown	Petroleum hydrocarbons	—	Unknown	Unknown	Unknown
General Purpose Grease, MIL-G-23549	Unknown	Petroleum hydrocarbons	—	Unknown	Unknown	Unknown

5.6.1.8 Towing and Mooring Systems (Operation and Maintenance)

Towing and mooring systems do not have the potential to contribute to deck runoff because the machinery requiring lubrication is stored and maintained below decks (Wenzel, *et al.*, 2001a).

5.6.1.9 Weapons Systems (Operation and Maintenance)

Fixed weapons systems are permanently fastened to the vessel. Oil (MIL-L-63460D) and grease (MIL-G-21164D) are used to lubricate the weapons system (Wenzel, *et al.*, 2001a). MIL-PRF-680, Type III dry cleaning solvent is used to clean weapons systems. Table 5-21 provides a list of material that may be discharged. The quantity of lubricant cleaner and grease was estimated based on shipboard observations. The quantity of dry cleaning solvent could not be determined due to the high variability of spills and use among vessels.

Table 5-21: Potential Discharge Materials for Weapon Systems

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (oz/fleet·yr)	Any BCCs Present?
Grease, MIL-G-21164D	1.1E+02	Synthetic ester	—	> 74	> 1.0E+04	None
		Lithium based soap thickener	—	> 12	> 1.6E+03	None
Cleaner, lubricant and preservative, MIL-L-63460D	3.9E+01	Unknown	—	Unknown	Unknown	Unknown
Dry Cleaning Solvent 6850-00-274-5421 (MIL-PRF-680 Type III)	Unknown	High purity hydrocarbon solvents	—	100	Unknown	Unknown

5.6.2 Summary of Feasibility and Environmental Effects Analysis: Deck Machinery and Weapons Lubrication

The TMP performance objective for deck machinery and weapons lubrication is for the vessel's responsible party to prevent the discharge of cleaning compounds, greases, hydraulic fluids, solvents, oils, fuels, and other materials associated with deck machinery and weapons lubrication that may negatively impact water quality.

Feasibility: Deck Machinery and Weapons Lubrication

The feasibility analysis determined that there were no significant personnel or cost impacts for the example deck machinery and weapons lubrication activities.

Environmental Effects: Deck Machinery and Weapons Lubrication

Lubrication of deck machinery and weapons causes the release of constituents from oil, grease, hydraulic fluids, and degreasers that can be entrained with deck runoff. The potential exists for trace amounts to remain on the deck and contribute to deck runoff both inside and outside 12 nm; causing a failure of oil and grease and color WQC endpoints.

Table 5-22 provides a summary of the example activities that were analyzed in the FIAR and EEAR. For a more in-depth discussion refer to the FIAR and EEAR.

Table 5-22: Summary of Analysis: Deck Machinery and Weapons Lubrication

Examples of Activities	Feasibility	Environmental Effects
Using a wire rope lubricator -More efficient process to remove and apply grease -Reduces discharge of grease	-Currently in place on some vessels -Unit cost $3,985 per lubricator	-Reduces the likelihood of sheen (from oil and grease) and turbidity
Using Covers or Protective Devices		
Chafing guards at friction points on exposed hydraulic hoses -Absorb friction of hoses, prevent leaks -Reduces discharge of oil	-Currently performed -Only cost is incorporation into the TMP	-Reduces the likelihood of sheen (from oil and grease) and color
Extensions on winch engine oil drains -Allow cleaner, more efficient draining of winch engine oil tanks -Reduces the discharge of oil	-Unit cost is $2,400 per vessel (Navy, 2001a)	-Reduces the likelihood of sheen (from oil and grease) and color
Fitted covers on cranes and mounts/weapons -Covering equipment prevents discharge of grease and hydraulic fluid	-Currently performed -Only cost is incorporation into the TMP	-Reduces the likelihood of sheen (from oil and grease) and color
Sample fittings on winch engines -Enables cleaner, more efficient sampling of winch engine oil -Prevents discharge of oil	-Unit cost is $1,560 per vessel (Navy, 2001a)	-Reduces the likelihood of sheen (from oil and grease) and color
Tarps used during equipment maintenance -Tarps collect constituents during maintenance -Prevent the discharge of oil and grease	-Currently performed -Only cost is incorporation into the TMP	-Reduces the likelihood of sheen (from oil and grease) and color

5.7 Category Summary: Exterior Topside Surface Preservation

Most vessels are subject to some type of preservation of exterior topside surface activities while afloat, with the exception of boats that are removed from the water after their daily use (Wenzel, *et al.*, 2001a).

5.7.1 Summary of Characterization: Exterior Topside Surface Preservation

The type and extent of preservation activities depends largely on vessel class and area of operation (Wenzel, *et al.*, 2001a). For example, due to differences in equipment and materials on deck, preservation requirements are significantly different between the 72 ft LCM 8 mechanized landing craft, a vessel used to transport tracked or wheeled vehicles and troops, and the similarly-sized Coast Guard 87 ft WPB, a vessel used for coastal patrol duties. The LCM 8 Class preservation system must withstand traffic from heavy, tracked and wheeled vehicles. The Coast Guard 87 ft WPB Class only requires a preservation system to withstand foot traffic on its decks. Similarly, a DDG 51 guided missile destroyer with periodic deployments to hot and dry climates (e.g., Persian Gulf) has different requirements for preservation of exterior topside surfaces than a DDG 51 vessel assigned to cold, humid climate (e.g., North Atlantic) (Wenzel, *et al.*, 2001a).

Current practices for the preservation of Navy and MSC vessels are described in NSTM Chapter 631 Volumes 1 to 3 *Preservation of Ships* (Navy, 1996a), Chapter 634 *Deck Covering* (Navy, 1995), and Chapter 583 *Boats and Craft* (Navy, 1998). The USCG painting and preservation practices are described in COMDTINST M10360 (series), *Coatings and Color Manual* (USCG, 2001), while the Army guidelines for preservation and painting of in-service watercraft are described in the Department of the Army 1990 Technical Bulletin TB 43-0144 (U.S. Army, 1990).

5.7.1.1 Restoration of Painted Surfaces

Paint chips and rust, generated from the restoration of painted surfaces, become trapped in the rough deck surface and contribute to deck runoff through rain and green water. Paint chips and associated debris are generated when rust and loose paint are removed with needle guns, blasting cleaning, and other paint removal equipment. Paint chip releases can also occur as a result of weathering processes that affect vessel superstructure surfaces (Wenzel, *et al.*, 2001a). Appendix L of the Navy's Environmental and Natural Resources Program Manual, Office of the Chief of Naval Operations (CNO) Instruction (OPNAVINST) 5090.1B and COMDTINST M10360.A specify that paint wastes, including chips and debris, must be containerized for shore disposal. However, it is expected that some of the fine-grain particles produced during surface preparation remain trapped in the rough deck surface and may contribute to deck runoff. Table 5-23 provides a list of material that may be discharged.

Table 5-23: Potential Discharge Materials for Restoration of Painted Surfaces

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Paint chips/debris (If below waterline)	Unknown	Copper as cuprous oxide	7440508	47	Unknown	Reduction
		Zinc as zinc oxide	7440666	15	Unknown	Reduction
Paint chips/debris (If above waterline)	Unknown	Unknown	---	Unknown	Unknown	None

5.7.1.2 Flight Deck Safety Nets (Operation and Maintenance)

Flight deck safety nets are located on all air capable vessels to prevent personnel from falling overboard. Flight deck safety nets are cleaned outside 12 nm using freshwater, and are unlikely to contribute constituents to deck runoff inside 12 nm.

5.7.2 Summary of Feasibility and Environmental Effect Analyses: Exterior Topside Surface Preservation

The TMP performance objective for exterior topside surface preservation is for the vessel's responsible party to prevent the discharge of rust (and other corrosion by-products), cleaning compounds, paint chips, non-skid material fragments, and other materials associated with exterior topside surface preservation that may negatively impact water quality.

Feasibility: Exterior Topside Surface Preservation

The feasibility analysis determined that the example practices are already in place; therefore there was no significant personnel or cost impacts for the example exterior topside surface preservation activities.

Environmental Effects: Exterior Topside Surface Preservation

Preservation of exterior surfaces releases paint chips and associated debris (e.g., non-skid material fragments, and rust). These fragments are settable material that, in large amounts, could potentially cause turbidity and affect the transparency and color of the receiving waters. Table 5-24 provides a summary of the example activities that were analyzed in the FIAR and EEAR. For a more in-depth discussion on the analyses refer to the FIAR and EEAR.

Table 5-24: Summary of Analysis: Exterior Topside Surface Preservation

Examples of Activities	Feasibility	Environmental Effects
Performing general housekeeping, such as sweeping and/or mopping, on the affected areas -Removes constituents from deck -Reduces discharge of paint	-Currently performed -Only cost is incorporation into the TMP	-Reduces the likelihood of color, settleable material, and turbidity
Using drop cloths when Removing and applying paint -Reduces paint chips and drips	-Currently performed -Only cost is incorporation into the TMP	- Reduces the likelihood of color, suspended solids, and turbidity
Using vacuum-assisted needle guns, sanders, and grinders -Uses a vacuum to collect paint chips and dust -Used on some Armed Forces vessels	-Unit cost is $5,460 for one system including vacuum, tools, and related equipment	-Reduces the likelihood of color, settleable material, and turbidity

5.8 Category Summary: Vessel, Aircraft, and Vehicle Refueling and Lubrication

All Armed Forces vessels, aircraft, and vehicles require some type of refueling or lubrication.

5.8.1 Summary of Characterization: Vessel, Aircraft, and Vehicle Refueling and Lubrication

Vessels, aircraft, and vehicles refueling and lubrication were assessed on CV/CVN, AOE 6 and LHD 1 class vessels. Although spills are cleaned up, residual aircraft fuel (JP-5) may contribute to deck runoff. In addition to fuel, small amounts of general purpose cleaner, grease, and anti-seize compounds are used at the fueling stations. Fixed wing aircraft maintenance may contribute to deck runoff in the form of hydraulic fluid and aircraft grease. Residual amounts of fuel, hydraulic fluid, grease, and anti-seize compounds may become trapped in the rough deck surface and subsequently contribute to deck runoff within 12 nm (Wenzel, *et al.*, 2001a).

Five processes of this category were evaluated for contributing constituents to deck runoff: (1) aircraft refueling; (2) fixed wing aircraft maintenance and operations; (3) fuel transfer systems; (4) ground support equipment; and (5) rotary wing aircraft maintenance and operations. These processes and their generation of constituents are described in subsections 5.8.1.1 through 5.8.1.5.

5.8.1.1 Aircraft Refueling

Aircraft refueling activities can occur both inside and outside 12 nm. The only jet fuel authorized for use aboard Navy ships and transport by fleet oilers is JP-5 jet fuel (MIL-DTL-5624T), which is a middle distillate specially blended kerosene (Navy, 1996b). Sources of JP-5 in deck runoff are from the residual of spills from aircraft tank vents, tank relief valves, and fueling station drains. Residual fuel has the potential to remain trapped in the rough deck surface and contribute to deck runoff. Table 5-25 provides a list of material that may be discharged. The quantity of fuel could not be determined due to the high variability of spills and use among vessels (Wenzel, *et al.*, 2001a).

Table 5-25: Potential Discharge Materials for Aircraft Fueling

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Fuel, JP-5 MIL-DTL-5624T	Unknown	Cycloalkanes	---	Unknown	Unknown	None
		n-Alkanes	---	Unknown	Unknown	None
		Monoaromatics	---	Unknown	Unknown	Unknown
		Branched alkanes	---	Unknown	Unknown	Unknown
		Benzene	71432	Unknown	Unknown	None
		Toluene	108883	Unknown	Unknown	None
		Ethylbenzene	100414	Unknown	Unknown	None
		Xylenes	1330207	Unknown	Unknown	None
		PAHs	---	Unknown	Unknown	Elimination & Reduction

5.8.1.2 Fixed Wing Aircraft Maintenance and Operations

Typical aircraft maintenance procedures that could produce deck runoff constituents include repairs to hydraulic lines and lubrication of aircraft, which occurs outside 12 nm. Although leaks and spills of hydraulic fluid (MIL-PRF-83282F) and aircraft grease (MIL-PRF-81322F) are immediately cleaned up, the possibility exists for trace amounts to remain on deck and contribute to deck runoff. Table 5-26 provides a list of material that may be discharged. The quantity of hydraulic fluid and grease could not be determined due to the high variability of leaks and use among vessels (Wenzel, *et al.,* 2001a).

Table 5-26: Potential Discharge Materials for Aircraft Operations, Fixed Wing

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Grease, MIL-PRF-81322F	Unknown	Mixture of paraffinic, naphthenic, and aromatic hydrocarbons	---	Unknown	Unknown	None
Hydraulic Fluid, MIL-PRF-83282D	Unknown	Synthetic hydrocarbon based oil	---	> 65	Unknown	None
		Ester based lubricant	---	< 35	Unknown	None

5.8.1.3 Fuel Transfer Systems (Operation and Maintenance)

Fuel transfer includes supplying of fuel to a vessel while pierside, fueling-at-sea (FAS) (see Figure 5.6), and refueling and de-fueling small boats onboard ships. Armed Forces vessels use three types of fuels: (1) motor gasoline (MOGAS) (ASTM D4814); (2) JP-5 (MIL-DTL-5624T); and (3) F-76 (MIL–F-16884J). Most FAS evolutions are conducted outside 12 nm.

MIL-G-24139A general-purpose grease is used to lubricate topside winches for FAS. Although any grease deposits are immediately cleaned up, the potential exists for trace amounts to become trapped in the rough deck surface and contribute to deck runoff.

Table 5-27 provides the material, description, and potential location of the processes that fuel may be used in. Although all fuel spills are immediately cleaned up, the potential exists for trace amounts to become trapped in the rough deck surface and contribute to deck runoff (Wenzel, *et al.*, 2001a).

Table 5-27: Fuel Transfer Systems Summary

Material	Description	Process Location
MOGAS (ASTM D4814)	-Powers spark ignition engines, predominantly outboard engines on small boats and combat vehicles	-The transfer of MOGAS between topside storage systems and boats can occur anywhere inside or outside 12 nm
JP-5 (MIL-DTL-5624T)	-Used in compression ignition engines of small boats and craft, and in ship's compression ignition (CI) engines, gas turbines, and boilers	-The transfer of JP-5 from on-deck storage systems to boats can occur anywhere inside or outside 12 nm
F-76 (MIL-F-16884J)	-The primary fuel used in shipboard power plants including diesels, gas turbines, and boilers (Navy 1996b)	-Traces amounts of F-76 may spill on the weather deck of a vessel during fueling pierside or while fueling or de-fueling boats and craft powered by CI engines inside or outside 12 nm -FAS between vessels only occurs while underway outside 12 nm

Figure 5.6: Fueling at Sea

Figure 5.6: UNREP Fueling At Sea (FAS) Connection. Australian supply ship AOR 304 transfers 330,000 gal of fuel to USN ship LHD 2. (Navy photograph by Stephanie M. Bergman.)

Table 5-28 provides a list of material that may be discharged. The quantity of MOGAS, fuel, and grease could not be determined due to the high variability of leaks and use among vessels (Wenzel, *et al.*, 2001a).

Table 5-28: Potential Discharge Materials for Fuel Transfer Systems

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Multipurpose Grease, MIL-G-24139A	Unknown	Petroleum hydrocarbons	---	Unknown	Unknown	Unknown
Fuel, JP-5 MIL-DTL-5624T	Unknown	Cycloalkanes	---	Unknown	Unknown	None
		n-Alkanes	---	Unknown	Unknown	None
		Monoaromatics	---	Unknown	Unknown	Unknown
		Branched alkanes	---	Unknown	Unknown	Unknown
		Benzene	71432	Unknown	Unknown	None
		Toluene	108883	Unknown	Unknown	None
		Ethylbenzene	100414	Unknown	Unknown	None
		Xylenes	1330207	Unknown	Unknown	None
		PAHs	---	Unknown	Unknown	Elimination & Reduction
Fuel, F-76 MIL-F-16884J	Unknown	Kerosene	8008206	Unknown	Unknown	Unknown
MOGAS ASTM D4814	Unknown	Gasoline	8006619	100	Unknown	Unknown

5.8.1.4 Ground Support Equipment (Operation and Maintenance)

Ground support equipment is comprised of vehicles and associated machinery used to move, start, and load aircraft. The main sources of constituents to deck runoff from this equipment are incidental leaks of hydraulic fluid (MIL-PRF-83282D and MIL-L-17331H) and engine oil (MIL-PRF-2104G). Other sources of constituents include motor oil (SAE J2362), power transmission fluid (MIL-F-17111C), lubricating oil (MIL-PRF-2105E), A-A-52624A antifreeze, JP-5 (MIL-DTL-5624T), JP-8 (MIL-DTL-83133E), and Dextron Type II or III automatic transmission fluid. Although leaks and spills are immediately cleaned after detection, the possibility exists for trace amounts to remain trapped on the rough deck surface and contribute to deck runoff both inside and outside 12 nm. Table 5-29 provides a list of material that may be discharged. The quantity of hydraulic fluid, lubricating oil, motor oil, power transmission fluid, antifreeze, fuel, and automatic transmission fluid could not be determined due to the high variability of leaks and use among vessels (Wenzel, *et al.*, 2001a).

Table 5-29: Potential Discharge Materials for Ground Support Equipment

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Fuel, JP-5 MIL-DTL-5624T	Unknown	Cycloalkanes	---	Unknown	Unknown	None
		n-Alkanes	---	Unknown	Unknown	None
		Monoaromatics	---	Unknown	Unknown	Unknown
		Branched alkanes	---	Unknown	Unknown	Unknown
		Benzene	71432	Unknown	Unknown	None
		Toluene	108883	Unknown	Unknown	None
		Ethylbenzene	100414	Unknown	Unknown	None
		Xylenes	1330207	Unknown	Unknown	None
		PAHs	---	Unknown	Unknown	Elimination & Reduction
Motor oil SAE J2362	Unknown	Petroleum oils	---	Unknown	Unknown	Unknown
Hydraulic Fluid MIL-PRF-83282D	Unknown	Synthetic hydrocarbon based oil	---	> 65	Unknown	Unknown
		Ester based lubricant	---	< 35	Unknown	Unknown
Lubricating oil MIL-L-17331H	Unknown	Unknown	---	Unknown	Unknown	Unknown
Antifreeze A-A-52624A	Unknown	Propylene glycol	57556	Unknown	Unknown	None
Power transmission fluid, MIL-DTL-17111C	Unknown	Synthetic hydrocarbon	—	< 75	Unknown	Unknown
		Methacrylate polymers	—	< 25	Unknown	Unknown
		Tricresyl phosphate	—	< 1	Unknown	Unknown
Lubricating Oil, MIL-PRF-2104G	Unknown	Petroleum hydrocarbons	—	Unknown	Unknown	Unknown
Lubricating Oil, MIL-PRF-2105E	Unknown	Petroleum hydrocarbons	—	Unknown	Unknown	Unknown
Dextron Automatic Transmission Fluid Type II or III 9150-00-657-4959	Unknown	Highly refined base oils	—	> 85	Unknown	Unknown
		Additives	—	< 15	Unknown	Unknown
Fuel, JP-8 MIL-DTL-83133E	Unknown	Cycloalkanes	---	Unknown	Unknown	None
		n-Alkanes	---	Unknown	Unknown	None
		Monoaromatics	---	Unknown	Unknown	Unknown
		Branched alkanes	---	Unknown	Unknown	Unknown
		Benzene	71432	Unknown	Unknown	None
		Toluene	108883	Unknown	Unknown	None
		Ethylbenzene	100414	Unknown	Unknown	None
		Xylenes	1330207	Unknown	Unknown	None
		PAHs	---	Unknown	Unknown	Elimination & Reduction

5.8.1.5 Rotary Wing Aircraft Maintenance and Operation

Rotary wing aircraft operation procedures that could produce deck runoff constituents include lubrication and repairs to hydraulic lines. MIL-PRF-83282D hydraulic fluid is used in rotary wing aircraft. Engine oil (MIL-PRF-23699F) is used to lubricate engine parts. Aircraft greases (e.g., MIL-PRF-81322F and MIL-G-23827C) are applied to struts, doors, and rotor heads. Although any lubricant or hydraulic fuels that spill on deck are immediately cleaned, constituents may be trapped in the rough deck surface and contribute to deck runoff. Table 5-30 provides a list of material that may be discharged. The quantity of hydraulic fluid, grease, and engine oil could not be determined due to the high variability of spills and use among vessels (Wenzel, *et al.*, 2001a).

Table 5-30: Potential Discharge Materials for Aircraft Operations, Rotary Wing

Potential Discharge Material	Potential Discharge Volume (gal/fleet·yr)	Bulk Constituents	CAS #	Composition (%)	Constituent Mass Loading (gal/fleet·yr)	Any BCCs Present?
Grease, MIL-PRF-81322F	Unknown	Mixture of paraffinic, naphthenic, and aromatic hydrocarbons	—	Unknown	Unknown	Unknown
Hydraulic Fluid, MIL-PRF-83282D	Unknown	synthetic hydrocarbon based oil	—	> 65	Unknown	Unknown
		Ester based lubricant	—	< 35	Unknown	Unknown
Grease, MIL-PRF-23827C	Unknown	synthetic ester	—	75 to 85	Unknown	None
		Lithium 12 hydroxystearate	7620771	10 to 15	Unknown	None
		Antimony dialkyldithiocarbamate	15890252	1-2	Unknown	None
		p,p'-Dioctyldiphenylamine	101677	1	Unknown	None
Engine Oil, MIL-PRF-23699F	Unknown	Polyol ester	68424317	0 to 90	Unknown	None
		Synthetic ester/fatty acids	68424339	0 to 90	Unknown	None
		Octylated N-phenyl-1-naphthylamine	68259369	< 2	Unknown	None
		p,p'-Dioctyldiphenylamine	101677	< 2	Unknown	None
		Tricresylphoshpate (mixed)	1330785	1	Unknown	None

5.8.2 Summary of Feasibility and Environmental Effect Analyses: Vessel, Aircraft, and Vehicle Refueling and Lubrication

The TMP performance objective for vessel, aircraft, and vehicle refueling and lubrication is for the vessel's responsible party to prevent the discharge of anti-freeze compounds, fuels, hydraulic fluids, oils, greases, and other materials associated with vessel, aircraft, and vehicle refueling and lubrication that may negatively impact water quality.

Feasibility: Vessel, Aircraft, and Vehicle Refueling and Lubrication

The feasibility analysis determined that there were no significant personnel or cost impacts for the example vessel, aircraft, and vehicle refueling and lubrication activities.

Environmental Effects: Vessel, Aircraft, and Vehicle Refueling and Lubrication

As explained in the EEAR, due to the nature of oil, grease, and fuel constituents generated by this topside process, the potential exists for incidental occurrences of sheens and discoloration of surface waters. For this category, only color and oil and grease narrative WQC could potentially fail.

Table 5-31 provides a summary of the example activities that were analyzed in the FIAR and EEAR. For a more in-depth discussion on the analyses refer to the FIAR and EEAR.

Table 5-31: Summary of Analysis: Vessel, Aircraft, and Vehicle Refueling and Lubrication

Examples of Activities	Feasibility	Environmental Effects
Minimizing Vessel, Aircraft, and Vehicle Refueling Inside 12 nm -Reduces discharge of fuel -Vessels do not transit outside 12 nm for refueling	-Currently performed -Only cost is incorporation into the TMP	-Within 12 nm, reduces the likelihood of color and sheen (from oil and grease). May increase loadings beyond 12 nm from shore -Constituents that were discharged within 12 nm are displaced to beyond 12 nm
Performing Hose Blowdown or Applying Back Suction to Drain the Hose -Reduces fuel left in hoses, lowering spill potential	-Currently performed -Only cost is incorporation into the TMP	-Reduces the likelihood of color, sheen (from oil and grease), and turbidity

5.9 Summary of Feasibility Analysis

The following section summarizes the findings of the overall deck runoff (versus category-specific) analyses.

5.9.1 Performance Objectives

Table 5-32 presents a summary of the performance objectives for each category.

Table 5-32: Performance Objective Summary

Category	Performance Objective
Aircraft Launch and Recovery Equipment	The vessel's responsible party to prevent the discharge of oils, greases, solvents, soot, and other materials associated with ALRE that may negatively impact water quality.
Buoy Maintenance	The vessel's responsible party to 1) prevent the discharge of rust, paint chips, paint drips, cleaning compounds, and other materials associated with buoy maintenance that may negatively impact water quality and 2) to prevent transport of non-indigenous species with fouling material and sediment released during buoy maintenance operations.
Cleaning Activities/General Housekeeping	The vessel's responsible party to prevent the discharge of cleaning compounds, hydraulic fluids, oils, fuels, greases, dirt, salts, soot, and other materials associated with cleaning activities/general housekeeping that may negatively impact water quality.
Deck Machinery and Weapons Lubrication	The vessel's responsible party to prevent the discharge of rust (and other corrosion by-products), cleaning compounds, paint chips, non-skid material fragments, and other materials associated with exterior topside surface preservation that may negatively impact water quality.
Exterior Topside Surface Preservation	The vessel's responsible party to prevent the discharge of rust (and other corrosion by-products), cleaning compounds, paint chips, non-skid material fragments, and other materials associated with exterior topside surface preservation that may negatively impact water quality.
Vessel, Aircraft, and Vehicle Refueling and Lubrication	The vessel's responsible party to prevent the discharge of anti-freeze compounds, fuels, hydraulic fluids, oils, greases, and other materials associated with vessel, aircraft, and vehicle refueling and lubrication that may negatively impact water quality.

5.9.2 Personnel Impact

The feasibility analysis determined that performing the activities in the TMP would not impact personnel because the activities are currently performed onboard most vessels. The only personnel impact would be conducting training on and maintaining both the FTMP and VTMP; however the impact is minimal.

5.9.3 Topside Management Plan Cost

Incremental costs are additional expenses that the Armed Forces would incur as a result of the implementation of UNDS regulatory requirements, and include initial and recurring costs. Most of the activities analyzed in the Deck Runoff FIAR are management practices that are currently in place on some or all Armed Forces vessels. The primary feasibility impact identified during determined by the analysis is the cost to create and implement a TMP (see Table 5-33). Table 5-34 summarizes the life-cycle costs of implementing and maintaining a TMP for the Navy, U.S. Coast Guard, and U.S. Army.

Table 5-33: TMP Implementation Costs

Armed Force	Line Item	Cost
Navy	Initial Start Up	$1,075,000 one time cost
	Two Representatives for the Feedback Loop	$320,000 annually
	Personnel Training	$400,000 annually
U.S. Coast Guard	Initial Start Up	$500,000 one time cost
	Development and Implementation of Policy Doctrine	$100,000 one time cost
	One Representative for the Feedback Loop	$160,000 annually
	Training Needs Analysis	$200,000 one time cost
	Performance Analysis	$200,000 one time cost
	Course Materials	$150,000 one time cost
U.S. Army	Initial Start Up	$100,000 one time cost
	One Representative (1/2 Time) for the Feedback Loop	$50,000 annually

Table 5-34: Summary of TMP Costs

Armed Force	Total Initial Cost ($K)	Total Recurring Cost ($K)	Incremental Cost ($K)
Navy	1,075	8,023	9,098
U.S. Coast Guard	600	2,340	2,940
U.S. Army	100	557	657

5.10 Summary of Environmental Effects Analysis

The following sections summarize the findings of the overall deck runoff (versus category-specific) analyses.

5.10.1 Bioaccumulative Contaminants of Concern

Four BCCs have been determined to have the potential to be present in deck runoff as shown in Table 5-35. Two of the identified BCCs are metals (copper and zinc), and two are organic compounds (Polynuclear Aromatic Hydrocarbon (PAH) and naphthalene).

Table 5-35: BCC Potentially Present in Deck Runoff

BCC	CAS Number	Elimination (E) Reduction (R)	Source
Copper	7440508	R	Buoy's ablative antifouling paints
Zinc	7440666	R	Buoy's ablative antifouling paints, anti-seize compound used with arresting gear and jet blast deflectors
Naphthalene	91203	R	Aircraft engine water wash
PAH	-	R	Traces amounts from fuels

5.10.2 Other Potential Environmental Impacts

Sensitive intertidal environments (e.g., wetlands, sea grass beds, and coral reefs) in the vicinity of large homeports could be subject to chronic exposure to constituents from oil, grease, and fuel.

The possibility exists that partially enclosed environments with a high number of ships and navigational buoys, such as some bays and estuaries, may accumulate paint chips in benthic sediments.

5.10.3 Uncertainty Analysis

The biggest source of EEA uncertainty is the variability of constituent concentrations in deck runoff processes among vessel classes. Deck runoff samples were not collected because the instances of runoff are infrequent, unpredictable and highly variable because deck runoff is principally the result of adverse weather conditions. Because of this variability and the difficulty of gathering a representative sample, statistically valid sampling would be impractical. Absence of sample data prevents the comprehensive characterization of constituents and therefore increases the level of uncertainty of the EEA. The EEA assumed highest impact conditions from the characterization data.

5.10.4 Introduction of Non-Indigenous Species

Deck runoff discharge is not expected to provide a mechanism for introducing non-indigenous species (NIS). Constituents expected to be present in deck runoff do not provide nutrients that could promote the survival of NIS.

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5.10.5 Summary of Water Quality Criteria Categories Determinations

Table 5-36 provides a summary of WQC categories for deck runoff (see *Environmental Effects Analysis Report: Deck Runoff*, Appendix A for details). Cells shaded gray identified discharge expected to fail narrative WQC; non-shaded cells identified DISCHARGES WITH non-exceeding narrative WQC. N/A indicates that the process does not apply (e.g., aircraft launch and recovery equipment is never used in freshwater).

Table 5-36: Summary Table of Narrative Water Quality Criteria Categories Determinations

Table Key: Blank cells = Expected to Pass WQC Fail = Expected to fail WQC	**Aircraft Launch and Recovery Equipment**		**Buoy Maintenance**		**Cleaning Activities General Housekeeping**		**Deck Machinery & Weapons Lubrication**		**Exterior Topside Surfaces Preservation**		**Vessels, Aircraft, and Vehicles Refueling and Lubrication**	
Saltwater Criteria Categories	**Base**	**TMP**	**Base**	**TMP**	**Base**	**TMP**	**Base**	**TMP**	**Base**	**TMP**	**Base**	**TMP**
BOD/DO												
Color	Fail		Fail	Fail	Fail		Fail		Fail		Fail	
Floating Materials	Fail											
Nutrients												
Odor												
Oil & Grease	Fail				Fail		Fail				Fail	
Pathogens												
Settleable Materials	Fail		Fail						Fail			
Suspended Solids	Fail		Fail	Fail								
Taste												
Temperature												
Turbidity/Colloidal Matter	Fail		Fail	Fail					Fail			
Freshwater Criteria Categories	**Base**	**TMP**	**Base**	**TMP**	**Base**	**TMP**	**Base**	**TMP**	**Base**	**TMP**	**Base**	**TMP**
Alkalinity	N/A	N/A										
Hardness	N/A	N/A										
Nutrients	N/A	N/A										
Oil & Grease	N/A	N/A					Fail				Fail	
Pathogens	N/A	N/A										
pH	N/A	N/A										
Specific Conductance	N/A	N/A										
Total Dissolved Solids	N/A	N/A										

6.0 Summary

Deck runoff is defined in 40 CFR 1700.4 as the precipitation, washdowns, and seawater falling on the weather deck and exposed portions of a vessel and discharged overboard through deck openings. A vessel intermittently produces deck runoff when water falls on or is applied to exposed surfaces, such as weather and flight decks, superstructure, bulkheads, and the hull above the waterline of a ship (e.g., freeboard and bulwark). Discharge constituents vary depending on the vessel's topside processes, and may include oil, grease, petroleum hydrocarbons, surfactants, cleaners, glycols, solvents, and particulates (e.g., soot, dirt, or metallic particles). All vessels generate deck runoff.[3]

The TMP was the only MPCD option that passed the screening process. It was examined in the environmental effects and feasibility impact analyses. The other MPCD options were not feasible because they required the collection of deck runoff. Collecting deck runoff is infeasible because of the large quantity of deck runoff generated.

Most Armed Forces vessels currently perform the activities that would be included under the TMP. Therefore, the primary cost of this MPCD would be the development of TMP documentation. The practices implemented would help prevent discharge of constituents from topside processes. Once implemented, the TMP would help prevent adverse environmental impacts from deck runoff. It would also create a baseline of environmental performance for all Armed Forces vessels.

The TMP would consist of a FTMP and a VTMP. The FTMP would address deck runoff constituent sources (i.e., categories), list activities that could be implemented to prevent the discharge of those constituents, and specify documentation procedures. The FTMP would be distributed to individual vessel program offices or commands, which would then develop a VTMP. A VTMP would identify deck runoff constituents and their sources for a particular vessel or a group of similar vessels. The VTMP would identify the objective for each applicable category, suggest or specify control practices to achieve the objective, and specify documentation requirements. Vessels would be free to add new, innovative ideas to their VTMP.

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[3] *To facilitate the UNDS Phase II analysis, the Discharge Assessment Team (DAT) determined that water that falls on or is applied to exposed surfaces and accumulates in the lowest part of the vessel (i.e., bilge) is classified as surface vessel bilgewater. Associated analyses are presented in the Surface Vessel Bilgewater Reports.*

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